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NTSB-INSPIRED IMPROVEMENTS IN
TRANSPORTATION SAFETY

This report address several safety issues in passengers aircraft from based on accident analysis for the last 25 years by National Transportation Safety Board (USA).

1 . <u>Ground Proximity Warning Systems</u>

On December 29, 1972, an Eastern Air Lines Lockheed L-1011 crashed into the Florida Everglades while on approach to Miami interrnational Airpor t. Almost two years later, on December 1, 1974, a TWA Boeing 727 crashed into a mountain while on approach to Washington Dulles International Airport in Virginia. One hundred ninety-one persons died in the two tragedies. There was one common factor: no mechanical malfunctions contributed to either accident. The Safety Board concluded that these accidents - termed (controlled flight into terrain,) or (CFIT) for short - could have been prevented by a terrain warning system in The Cockpit.

the Federal Aviation Administration (FAA) began to require large passenger aircraft to be equipped with a ground proximity warning system (GPWS). This device warns flight crews if their aircraft approaching terrain, descending too quickly, or improperly configure for landing, usually with an aural warning like (Pull Up, Pull) Terrain.(This requirement has dramatically lowered the frequency of CIFT accidents.

Another CFIT accident prompted the Safety Board to recommend that the FAA require aircraft to be equipped with the next generation of (enhanced) GPWS, which gives flight crews significantly more advance warning. The recommendation grew out of the December 20, 1995, crash of an American Airlines Boeing 757 on approach to Cali, Colombia, killing all but four of the 163 persons on board . During the descent, with the speed brakes extended, the pilots failed to clear the mountain following a ground proximity warning.

2 . <u>Fire Safety</u>

Cabin fires, although extremely rare in passenger airliners, can be devastating. In July 1973, the Safety Board assisted French authorities in their investigation of the crash landing of a Varig Boeing 707 near Paris after a fire in a rear lavatory. Two months later, the Board asked the FAA to require smoke detectors or frequent in-flight checks of lavatories by flight attendants for early detection of fires. Another in-flight fire, this time involving a Pan American Boeing 707 cargo flight, occurred in November 1973. And in the summer of 1974, two more airliner lavatory fires, both nonfatal, prompted the Board to recommend specifically that the FAA require installation of automatic-discharge fire extinguishers in lavatory waste paper containers in all airliners. The FAA required airlines to prohibit smoking in lavatories. The agency also urged routine flight attendant inspections of lavatories before takeoff and periodic inspections during flight.

Most of the Board s have resulted in the following fire safety improvements on airliners:

- Smoke detectors and automatic-discharge fire extinguishers in lavatories. Stiff fines are also imposed when anyone attempts to disable a smoke detector;
- Floor-level escape lighting along aisles that guide passengers toward an exit should visibility be reduced by smoke; and
- Fire-blocking cabin and seat materials, which are required on all airliners built after August 19, 1990.

Older aircraft receive the new materials when they undergo a complete refurbishment. Safety Board investigators credited fire - blocking seat materials with saving lives following a takeoff accident and fire aboard a Delta Air Lines Boeing 727 at Dallas/Fort Worth in August 31, 1988. A study showed that fire - blocking materials gave passengers additional time to exit the aircraft .

Another concern related to fire safety is the heat-re capability of material on evacuation slides.

Cargo compartment fires are another fire safety concern. in 1981, a Saudi Arabian Airlines Lockheed L-1011 experienced an in- flight fire after departure from Riyadh for Jeddah. The investigation revealed that the design of Class C compartments did not meet the intent of regulations that required Class C compartments to smother a fire. Safety recommendations issued by the Board after this accident led to major modifications to all wide body airplane Class C cargo compartments aimed at preventing a fire f rom spreading.
On May 11, 1996, a ValuJet DC-9 crashed in Miami after a fire erupted in a cargo compartment. The Safety Board investigation concluded that activation of one or more chemical oxygen generators in the forward Class D cargo compartment initiated the fire. In early 1998, the FAA issued a rule requiring fire detection and suppression systems in all the cargo holds of 3,700 aircraft by 2001.

3 . <u>Wind Shear</u>
Since 1970 to 1985 18 Fatal accident were attributable to phenomenon now known as wind shear.
As a result of the Safety Board s recommendations ,research efforts were launched that greatly increased our knowledge and understanding of the wind shear phenomenon. Among the safety improvements developed as a result of these recommendations were enhanced winds hear training for pilots and low-level wind shear alert systems installed at all major airports. The Board also recommended the installation of Terminal Doppler Weather Radar (TDWR), an integral part of these alert systems, to provide pilots with more timely and accurate weather information.
The Safety Board believes that the enhanced radar would have given controllers the opportunity to issue timely information to the flight crew about the severity of the weather and may have prevented the accident. As of mid-1998, 37 TDWR facilities had been commissioned in airports throughout the country and the FAA is developing an advanced onboard weather detection system.

4 . <u>Icing</u>
Nine icing-related commercial aviation crashes have occurred since 1982 in the United States alone, involving transpor t category aircraft and commercial passenger aircraft . Beginning in 1975, the Safety Board issued numerous safety recommendations addressing the measurement, forecasting , avoidance, and protection of aircraft against such icing conditions.

5 . <u>Midair Collision</u>
As air traffic continues its rapid growth, the airspace used by aircraft does not expand. With more aircraft flying more often in this finite airspace, advances in collision avoidance technology critical to maintaining adequate separation of aircraft . Since 1967, the Safety Board has recommended and supported the development of an airborne collision avoidance system that would be independent of the ground-based air traffic control system to provide pilots with an additional source of information on potential conflicts in flight. Since 1993, transport category aircraft have been equipped with traffic alert and collision avoidance systems (TCAS). General aviation aircraft operating in controlled airspace near major airports are now re q u i red to be equipped with Mode C transponders, which give air traffic controllers altitude information. Mode C transponders provide several major benefits: they permit radar to automatically display the altitudes of aircraft equipped with them; they provide air traffic control computers with route and altitude information that sound alarms when imminent collision hazards are detected. This technology has greatly enhanced the prevention of midair collisions and near- collision . All air traffic controllers now receive annual TCAS training as a result of Safety Board recommendations. This training explains the operation of TCAS and the roles and responsibilities of flight crews in responding to TCAS alerts. Thanks, at least in part, to the installation of anti-collision equipment and the improved air traffic controller training, several midair collisions involving transport category aircraft have been avoided in the United States.

6 . Rejected tak-off

On May 21, 1988, an American Airlines DC-10, operating near maximum gross weight, was damaged beyond economical repair during a rejected takeoff at Dallas/Fort Worth International Airport . During the rejected takeoff, the airplane decelerated normally for five to six seconds, and then did not continue to adequately decelerate, resulting in the airplane running off the end of the runway at a g round speed of about 97 knots. Only two of the 255 occupants w ere injured . Evidence showed that the airplanes brakes failed during the rejected takeoff. If the brakes had not failed, the airplane could have stopped on the runway. Examination of the airplanes wheel brake system revealed that eight of the 10 brakes totally failed when the brake friction material depleted. Before the rejected takeoff, the brakes were near the established replacement limit of 0.7 inch. Certification flight test data showed that new brakes, which have about 2.7 inches of material available, wear, on average, about 1.5 inches during a rejected takeoff. With brake material allowed to wear down to 0.7 inch before replacement, the replacement limit was clearly unacceptable. The limits had been established to ensure that the brakes would not be damaged during normal friction material w e a r, not necessarily to survive a rejected takeoff . The Safety Board determined that this oversight evolved from the FA As acceptance of inadequate certification testing procedures , including using new brakes instead of worn brakes; testing during a landing rather than a rejected takeoff; and inadequate dynamometer testing. At the Board s urging, the FAA issued airworthiness directives improving allowable brake wear limits on transport category airplanes. The Safety Board also conducted a special investigation on the safety of rejected takeoffs and found serious shortcomings in pilot training concerning possible rejected takeoff hazards. In response , Boeing, working together with segments of the aviation industry, developed a rejected takeoff training aid to improve pilot training in this important area. This training aid has since become an FA A advisory circular and is widely used throughout the industry.

7 . Runway Overruns

Although the FAA requires a 1,000-foot safety area at the end of newly constructed runways. some runways built before that standard was enacted are adjacent to wetlands, water ways, or sharp terrain drop offs that do not allow the minimum safety area . Consequently, another method is needed to protect aircraft on these runways .

In 1984, following its safety study on airport certification, the Safety Board recommended that FAA (initiate research and development activities to establish the feasibility of soft-ground aircraft arresting systems and promulgate a design standard, if the systems are found to be practical.) Soft-ground systems use material that will deform readily and reliably when an aircraft traverses it. As the tires crush the material, the drag forces decelerate the aircraft . The extensive research that followed this recommendations resulted in the development of a cellular concrete system that was tested at the FA As Technical Center in Atlantic City. In November 1996, the Port Authority of New York and New Jersey installed a 400-foot-long arrestor bed for runway 4R at JFK International Airport . Arrestor beds for runways 13 and 22 at LaGuardia are planned for 1998. This is a major step in mitigating the effects of potentially dangerous runway overruns at airports in the United States and a round the world.

8 . Alcohol and Aviation

Since 1984, the Safety Board has asked the FAA to use the National Driver Register (NDR) to help identify airmen whose drivers licenses have been suspended for alcohol-related offenses. Such pilots may have alcohol dependencies that could affect their ability to safely operate an aircraft .

In November 1988, the FAA issued regulations to identify pilots involved in alcohol- or drug - related motor vehicle offenses resulting in convictions or administrative actions. The new regulations, which went into effect in 1990, require pilots to report any alcohol- or drug - related driving conviction or administrative action within 60 days. Pilots applying for a medical certificate must consent to the release

of NDR information. To detect pilots DWI (driving while intoxicated)convictions the FAA is systematically matching names of those holding the aviation medical certificates with the NDR and law enforcement records .
Airlines are now required to perform pre-employment, random, and post accident drug testing for the presence of certain illicit drugs in persons employed in safety-sensitive positions. The requirement has been expanded to include post accident testing for alcohol.

9 . <u>Aircrafts Seats</u>
For years the Safety Board has recommended that the FAA establish higher crashworthiness standards for passenger and crew seats to better prevent seat failures and protect persons in accidents. In minor-to-moderate aircraft crashes, the occupants often are thrown about or ejected because of seat failure.
In May 1988, the FAA published its final rule upgrading the crashworthiness of seats on newly certificated transport category aircraft from 9 Gs to 16 Gs and, for the first time, requiring that seats be tested dynamically for their strength in addition to the current requirement for static testing.

10 . <u>Crew Resources Management</u>
In a number of airline accidents investigated by the Safety Board in the 1960s and 1970s, the Board detected a culture and work environment in the cockpit that, rather than facilitating safe transportation , may have contributed to the accidents. The Board found that some captains treated their fellow cockpit crewmembers as underlings who should speak only when spoken to. This intimidating atmosphere actually led to accidents when critical information was not communicated among cockpit crewmembers.
the concept of crew resource management, (CRM), was born. Following pioneering work by the National Aeronautics and Space Administration (NASA), the Safety board issued recommendations to the FAA and the airline industry to adopt methods that encourage teamwork, with the captain as the leader who relies on the other crewmembers for vital safety-of-flight tasks and also shares duties and solicits information and help from other
crewmembers. United Airlines was one of the first airlines to adopt this concept, which is endorsed by pilot unions and is now almost universally used by the major airlines (as well as in other modes of transportation). The Board has also recommended and the FAA has acted to implement CRM for regional and commuter airlines.

11 . <u>Structural Fatigue and Corrosion</u>
On April 28, 1988, an Aloha Airlines Boeing 737-200 airplane experienced a structural failure and explosive decompression at 24,000 feet while en route from Hilo to Honolulu, Hawaii. Approximately 18 feet of fuselage skin and structure, above the passenger floor and aft of the main cabin entrance door, separated from the airplane in flight. One flight attendant was swept out of the plane during the decompression and killed. Although power from one engine was lost and there were control difficulties, the flight crew performed an emergency descent and landing at Kahului Airport, on Maui, without further incident.
The Safety Board s investigation revealed that the fuselage failure was caused by disbonding of the fuselage lap joints and multi-site fatigue cracking. As a result of the investigation, the Safety Board issued over 20 recommendations that addressed shortcomings in the maintenance and repair of the aircrafts structure . These recommendations and the Board s accident investigation greatly increased the industry s understanding of aging aircraft structural issues. As a result, the FAA requires increased fatigue testing on newly certified airplanes. Older aircraft are subjected to periodic reviews, inspections, and modifications to eliminate corrosion and metal fatigue.

12 . <u>Fuel Tank Explosions</u>

On July 17, 1996, a Trans World Airlines Boeing 747-100 experienced an in-flight explosion of its center wing fuel tank near East Moriches, New York, shortly after takeoff from JFK International Airport, New York. The extensive investigation and recommendations have resulted in safety improvements made in coordination with Boeing and the FAA. This has led to greater industry understanding of the hazards posed by fuel vapor at elevated temperatures in fuel tank ullage, flammability and ignition energies of Jet A fuels, shortcomings in fuel tank electrostatic and lightning protection , electrical surge protection for fuel quantity indication systems, improved fuel pump safety, and understanding of aging wiring issues . With respect to the 747 fleet, the Safety Boards recommendations have resulted in fuel system product improvements, service bulletins, notices of proposed rule
making , and airworthiness directives to correct issues that have been uncovered. As the investigation progresses, the industry is more aggressively addressing aging wiring issues to eliminate ignition Sources in other aircraft models in the air carrier fleet.